Technical Paper 100

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PRINCETON

DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
JOSEPH A. HOLMES, DIRECTOR

PERMISSIBLE EXPLOSIVES

TESTED PRIOR TO MARCH 1, 1915

BY

SPENCER P. HOWELL

WASHINGTON
GOVERNMENT PRINTING OFFICE
1915

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DEPARTMENT OF THE INTERIOR.

BUREAU OF MINES.

JOSEPH A. HOLMES, DIRECTOR.

SUPPLEMENTARY LIST OF PERMISSIBLE EXPLOSIVES.

The following list contains the names of all permissible explosives tested by the Bureau between March 1 and July 1, 1915.

Permissible explosives tested prior to March 1, 1915, are listed in Technical Paper 100. The definition of a permissible explosive and information on the classes and brands of those permissible explosives tested prior to March 1, 1915, are given in Technical Paper 100, as are the unit deflective charge (which represents in a way the "coal-getting" strength of the explosive), the rate of detonation, and definitions of the classes of permissible explosives.

Permissible explosives tested between Mar. 1 and July 1, 1915.

Brand.	Class designation.	When used with detonators, preferably electric detonators, of not less efficiency than—	Unit deflective charge.
			Grams.
Bituminite No. 8–L. F	Class 4	No. 6	303
Cameron mine powder No. 5–A	do	do	299
Tunnelite AA	Class 1a	do	253
Tunnelite No. 3	Class 4	do	291
Tunnelite No. 4	do	do	309

Brand.	Rate of detonation in 1¼ by 8 inch cartridge.		Manufacturer.
	Feet per second.	Meters per second.	
Bituminite No. 8–L. F	9,300	2,834	Jefferson Powder Co., Birmingham, Ala.
Cameron mine powder No. 5–A	8,900	2,712	Cameron Powder Manufacturing Co., Emporium, Pa.
Tunnelite AA	7,690	2,346	G. R. McAbee Powder & Oil Co., Pittsburgh, Pa.
Tunnelite No. 3	10,110	3,083	Do.
Tunnelite No. 4	10,620	3,238	Do.

Approved, July 1, 1915.

JOSEPH A. HOLMES, *Director.*

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PERMISSIBLE EXPLOSIVES TESTED PRIOR TO MARCH 1, 1915.

By SPENCER P. HOWELL.

GENERAL STATEMENT.

The table following contains the brand names of all explosives now considered to be permissible explosives that were tested by the Bureau of Mines prior to March 1, 1915.

Further information on permissible explosives may be found in Bureau of Mines publications, as follows: Miners' Circular 6, "Permissible Explosives Tested Prior to January 1, 1912, and Precautions to be Taken in Their Use," gives the precautions to be observed in the handling, storage, and use of permissible explosives; Schedule 1 (September, 1913), "Fees for Testing Explosives," gives the conditions under which Bureau of Mines tests of explosives will be made and the test requirements of permissible explosives; Bulletin 15, "Investigations of Explosives used in Coal Mines," and Bulletin 66, "Tests of Permissible Explosives," describe the physical tests of most of the permissible explosives herein listed, and the apparatus used in the tests; and Bulletin 17, "A Primer on Explosives for Coal Miners," Bulletin 10, "The Use of Permissible Explosives," Bulletin 80, "A Primer on Explosives for Metal Miners and Quarrymen," and Miners' Circular 7, "The Use and Misuse of Explosives in Coal Mining," discuss the storing, handling, and use of permissible explosives.

There were 116 explosives on the permissible list on January 1, 1914. During the succeeding 14 months 19 explosives were added to the list and 6 explosives were dropped, in most instances because the manufacturer no longer desired to market them, and are no longer denominated permissible explosives. The present list takes the place of all preceding lists and includes a total of 129 explosives.

DEFINITION OF PERMISSIBLE EXPLOSIVE.

An explosive is called a permissible explosive when it is similar in all respects to the sample that passed certain tests by the United States Bureau of Mines, and when it is used in accordance with the conditions prescribed by this bureau.

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But even the explosives that have passed those tests and are named in this list as permissible explosives are to be considered as permissible explosives only when used under the following conditions:

1. That the explosive is in all respects similar to the sample submitted by the manufacturer for test.

2. That detonators—preferably electric detonators—are used of not less efficiency than those prescribed, namely, those consisting by weight of 90 parts of mercury fulminate and 10 parts of potassium chlorate (or their equivalents).

3. That the explosive, if frozen, shall be thoroughly thawed in safe and suitable manner before use.

4. That the quantity used for a shot does not exceed 1½ pounds (680 grams), and that it is properly tamped with clay or other noncombustible stemming.

It must not be supposed that an explosive that has once passed the required tests and has been published in lists of permissible explosives is always thereafter to be considered a permissible explosive, regardless of its condition or the way in which it is used. Thus, for example, an explosive named in the permissible list, if kept in a moist place until it undergoes a change in character, is no longer to be considered a permissible explosive. If used in a frozen or partly frozen condition, it is not when so used a permissible explosive. If used in excess of the quantity specified (1½ pounds), it is not, when so used, a permissible explosive. And when the other conditions have been met, it is not a permissible explosive if fired with a detonator of less efficiency than that prescribed.

Moreover, even when all the prescribed conditions have been met, no permissible explosive should necessarily be considered as being placed *permanently* on the permissible list, for the bureau reserves the right, on fuller information concerning the conditions which lead to safety, to revise this list, but any permissible explosive when used under the prescribed conditions may properly continue to be considered a permissible explosive until notice of its withdrawal or removal from the list has been officially published, or until its name is omitted from a later list published by the Bureau of Mines.

Furthermore, the manufacturers of a permissible explosive may withdraw it at any time when introducing a new explosive of superior qualities. And after further experiments and conferences the Bureau of Mines may find it advisable to adopt additional and more severe tests to which all permissible explosives may be subjected, in the hope that through the use of such explosives only as may pass the more severe tests the lives of miners may be better safeguarded.

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LIST OF PERMISSIBLE EXPLOSIVES.

Subject to the conditions and provisions stated above, the following explosives are classed as permissible explosives:

Permissible explosives tested prior to March 1, 1915.

Brand.	Class designation.	When used with detonators, preferably electric detonators, of not less efficiency than—	Unit deflective charge.	Rate of detonation in 1¼ by 8 inch cartridge.		Manufacturer.
			Grams.	*Feet per second.*	*Meters per second.*	
Aetna coal powder A [1]	Class 4	No. 6	277	12, 620	3, 848	Aetna Explosives Co. (Inc.), New York, N. Y.
Aetna coal powder AA [1]	Class 1*a*	do	241	7, 880	2, 403	Do.
Aetna coal powder B [1]	Class 4	do	301	9, 870	3, 008	Do.
Aetna coal powder C [1]	do	do	344	7, 010	2, 138	Do.
Aetna coal powder No. 2 [1]	Class 1*a*	do	212	9, 280	2, 830	Do.
Bental coal powder No. 1–A [2]	do	do	278	7, 690	2, 343	Hercules Powder Co., Wilmington, Del.
Bental coal powder No. 2 [2]	do	No. 7	276	4, 750	1, 447	Do.
Bental coal powder No. 2–X [2]	do	No. 6	280	7, 980	2, 432	Do.
Bituminite No. 1	Class 4	do	318	12, 800	3, 901	Jefferson Powder Co., Birmingham, Ala.
Bituminite No. 3	do	do	294	9, 330	2, 843	Do.
Bituminite No. 4	do	do	301	7, 540	2, 298	Do.
Bituminite No. 5	Class 1*a*	do	231	9, 120	2, 782	Do.
Black Diamond No. 2–A	Class 4	do	281	12, 600	3, 842	Illinois Powder Manufacturing Co., St. Louis, Mo.
Black Diamond No. 3–A	do	do	294	11, 160	3, 402	Do.
Black Diamond No. 5	Class 1*a*	do	288	6, 020	1, 835	Do.
Black Diamond No. 6–L. F.	Class 4	do	306	9, 630	2, 935	Do.
Black Diamond No. 7	Class 1*a*	do	214	10, 730	3, 270	Do.
Black Diamond No. 8	Class 4	do	295	8, 730	2, 663	Do.

[1] Manufacture by Aetna Explosives Co. (Inc.), authorized under date of Dec. 31, 1914.

[2] Manufacture by Hercules Powder Co., authorized under date of June 12, 1914.

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Permissible explosives tested prior to March 1, 1915—Continued.

Brand.	Class designation.	When used with detonators, preferably electric detonators, of not less efficiency than—	Unit deflective charge.	Rate of detonation in 1¼ by 8 inch cartridge.		Manufacturer.
			Grams.	*Feet per second.*	*Meters per second.*	
Cameron mine powder No. 1–A	Class 1*a*	No. 6	227	10, 950	3, 339	Cameron Powder Manufacturing Co., Emporium, Pa.
Cameron mine powder No. 2–A	do	do	230	[1] 10, 520	3, 206	Do.
Cameron mine powder No. 2–A, L. F.	do	do	233	10, 950	3, 338	Do.
Cameron mine powder No. 3–A	Class 4	do	296	10, 930	3, 333	Do.
Carbonite No. 1	do	do	259	10, 950	3, 338	E. I. du Pont de Nemours Powder Co., Wilmington, Del.
Carbonite No. 2	do	do	302	11, 380	3, 470	Do.
Carbonite No. 2–L. F.[2]	do	do	305	7, 830	2, 387	Do.
Carbonite No. 3	do	do	325	8, 710	2, 656	Do.
Carbonite No. 4	do	do	327	7, 670	2, 339	Do.
Carbonite No. 5	do	do	304	10, 140	3, 092	Do.
Carbonite No. 6	do	do	345	7, 490	2, 285	Do.
Coalite X	Class 1*a*	do	226	9, 000	2, 745	Atlas Powder Co., Wilmington, Del.
Coalite No. 1	Class 4	do	296	7, 930	2, 418	Do.
Coalite No. 2–D	do	do	310	8, 430	2, 571	Do.
Coalite No. 2–D. L	do	do	271	7, 340	2, 237	Do.
Coalite No. 2–M, L. F	do	do	301	9, 220	2, 811	Do.
Coalite No. 3–X	Class 1*a*	do	274	7, 290	2, 223	Do.
Coalite No. 3–XC	do	do	250	8, 320	2, 536	Do.
Coal special No. 1[3]	Class 4	do	288	11, 800	3, 598	Aetna Explosives Co. (Inc.), New York, N. Y.
Coal special No. 1–A[3]	do	do	276	9, 370	2, 857	Do.
Coal special No. 1–L. F.[2]	do	do	277	8, 280	2, 524	Do.
Coal special No. 2[5]	do	do	304	10, 240	3, 123	Do.
Coal special No. 2–W[3]	do	do	277	11, 590	3, 534	Do.
Coal special No. 3–C[3]	do	do	288	9, 760	2, 977	Do.
Collier powder B, N. F.[3]	Class 1*a*	do	224	10, 950	3, 338	Do.

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Collier powder KN [3]	do	do	222	11,610	3,539	Do.
Collier powder No. X [3]	do	do	273	7,820	2,384	Do.
Collier powder X, L. F. [3]	do	do	252	9,990	3,047	Do.
Collier powder No. 2 [3]	Class 4	do	300	8,870	2,704	Do.
Collier powder No. 5 [3]	Class 1*a*	do	240	8,280	2,524	Do.
Collier powder No. 5–L. F. [3]	do	do	232	9,370	2,858	Do.
Collier powder No. 5 special [3]	do	do	236	8,330	2,541	Do.
Collier powder No. 6–L. F. [3]	Class 4	do	317	9,660	2,944	Do.
Collier No. 9 [3]	Class 1*a*	do	283	6,690	2,040	Do.
Collier powder No. 11 [3]	do	do	217	11,680	3,561	Do.
Collier powder No. 11–L. F. [3]	do	do	226	10,850	3,307	Do.
Cronite No. 1	do	do	233	10,490	3,198	G. R. McAbee Powder & Oil Co., Pittsburgh, Pa.
Cronite No. 5	do	No. 7	249	8,090	2,466	Do.
Detonite special	do	do	312	[4] 10,840	3,305	The King Powder Co., Cincinnati, Ohio.
Eureka No. 2	Class 2	No. 6	311	10,720	3,269	G. R. McAbee Powder & Oil Co., Pittsburgh, Pa.
Fort Pitt mine powder No. 1	Class 4	do	293	11,230	3,424	Fort Pitt Powder Co., Pittsburgh, Pa.
Fuel-ite No. 1	do	do	288	11,150	3,400	Burton Powder Co., Pittsburgh, Pa.
Fuel-ite No. 2	do	do	289	8,240	2,512	Do.
Fuel-ite No. 3	Class 1*a*	do	215	8,590	2,620	Do.
Giant coal-mine powder No. 5	Class 1*a*	No. 6	228	10,230	3,118	Giant Powder Co., Con., Giant, Cal
Giant coal-mine powder No. 6	Class 2	do	277	11,550	3,520	Do.
Giant coal-mine powder No. 7	do	do	245	10,830	3,301	Do.
Giant coal-mine powder No. 8	do	do	247	10,830	3,301	Do.
Guardian A [5]	Class 4	No. 7	296	10,130	3,089	Hercules Powder Co., Wilmington, Del.
Guardian No 2 [5]	Class 1*a*	No. 6	245	8,980	2,738	Do.
Guardian No. 2–X [5]	do	do	245	7,990	2,437	Do.
Guardian No. 3 [5]	do	do	272	7,660	2,336	Do.
Guardian No. 3–X [5]	do	do	252	8,470	2,582	Do.
Guardian coal powder B [5]	Class 4	No. 7	310	8,960	2,733	Do.
Hecla No. 2	Class 1*a*	do	253	13,990	4,264	E. I. du Pont de Nemours Powder Co., Wilmington, Del.
Hygrade coal powder No 2	Class 4	No. 6	329	8,450	2,576	Hygrade Powder Co., Philadelphia, Pa.
Kanite A	Class 1*b*	No. 8	255	[4] 10,730	3,270	W. H. Blumenstein Chemical Works, Pottsville, Pa.

[1] 1¼-inch cartridges used.
[2] Replaced on the permissible list under date of Jan. 12, 1915.
[3] Manufacture by Aetna Explosives Co. (Inc.), authorized under date of Jan. 11, 1915.
[4] 1¾-inch cartridges used.
[5] Manufacture by Hercules Powder Co. authorized under date of June 12, 1914.

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Permissible explosives tested prior to March 1, 1915—Continued.

Brand.	Class designation.	When used with detonators, preferably electric detonators, of not less efficiency than—	Unit deflective charge.	Rate of detonation in 1¼ by 8 inch cartridge.		Manufacturer.
			Grams.	*Feet per second.*	*Meters per second.*	
Lomite No. 1	Class 2	No. 6	300	13,940	4,250	G. R. McAbee Powder & Oil Co., Pittsburgh, Pa.
Lowinite No. 2–B	Class 1*a*	do	258	9,740	2,971	Lowinite Explosives Manufacturing Co., Pittsburgh, Pa.
Meteor AXXO	Class 2	do	434	8,410	2,563	E. I. du Pont de Nemours Powder Co., Wilmington, Del.
Mine-ite A	Class 4	do	296	11,290	3,443	Burton Powder Co., Pittsburgh, Pa.
Mine-ite A–2	do	do	319	10,670	3,252	Do.
Mine-ite B	do	do	340	9,540	2,908	Do.
Mine-ite B–2	do	do	334	7,410	2,260	Do.
Mine-ite No. 5–D	Class 1*a*	do	241	8,720	2,658	Do.
Mine-ite No. 6–D	do	do	224	8,090	2,467	Do.
Miners Friend No. 1	do	do	233	11,580	3,529	Atlas Powder Co. Wilmington, Del.
Miners Friend No. 2	do	do	260	10,330	3,149	Do.
Miners Friend No. 3	do	do	252	8,030	2,449	Do.
Miners Friend No. 4	do	do	261	9,980	3,044	Do.
Miners Friend No. 5	do	do	250	8,570	2,614	Do.
Miners Friend No. 6	do	do	234	10,900	3,324	Do.
Monobel No. 1	do	do	216	11,700	3,568	E. I. du Pont de Nemours Powder Co., Wilmington, Del.
Monobel No. 2	do	do	239	9,870	3,009	Do.
Monobel No. 3	do	do	243	7,260	2,212	Do.
Monobel No. 4	do	do	248	8,980	2,738	Do.
Monobel No. 5	do	do	267	6,760	2,061	Do.
Monobel No. 6	do	do	218	10,380	3,165	Do.
Monobel No. 7	do	do	211	10,050	3,065	Do.
Nitro low-flame No. 1	Class 4	do	303	13,380	4,079	Nitro Powder Co., Kingston, N. Y.
Nitro low-flame No. 2	do	do	298	14,560	4,439	Do.

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Red H No. 1	Class 1*a*	do	216	11,700	3,568	Hercules Powder Co., Wilmington, Del.
Red H No. 2	do	do	239	9,870	3,009	Do.
Red H No. 3	do	do	243	7,260	2,212	Do.
Red H No. 4	do	do	248	8,980	2,738	Do.
Red H No. 5	do	do	267	6,760	2,061	Do.
Red H No. 6	do	do	218	10,380	3,165	Do.
Red H No. 7	do	do	211	10,050	3,065	Do.
Trojan coal powder H	Class 3	do	394	9,420	2,872	Pennsylvania Trojan Powder Co., Allentown, Pa.
Trojan coal powder I	do	do	410	9,620	2,934	Do.
Trojan coal powder J	do	do	360	10,590	3,230	Do.
Tunnelite B	Class 1*a*	do	249	9,990	3,047	G. R. McAbee Powder & Oil Co., Pittsburgh, Pa.
Tunnelite C	do	do	255	10,060	3,068	Do.
Tunnelite No. 5	Class 4	do	328	8,400	2,562	Do.
Tunnelite No. 6	do	do	305	9,670	2,947	Do.
Tunnelite No. 6–L. F	do	do	301	9,620	2,933	Do.
Tunnelite No. 7	do	do	311	8,720	2,659	Do.
Tunnelite No. 8	do	do	324	8,020	2,446	Do.
Tunnelite No. 8–L. F	do	do	322	8,720	2,658	Do.
Vigorite No. 1	do	do	259	10,950	3,338	Atlas Powder Co., Wilmington, Del.
Vigorite No. 2	do	do	298	10,920	3,330	Do.
Vigorite No. 3	do	do	320	8,140	2,483	Do.
Vigorite No. 4	do	do	341	7,480	2,281	Do.
Vigorite No. 5	do	do	308	10,830	3,303	Do.
Vigorite No. 6	do	do	345	7,490	2,285	Do.
Xpdite No. 1	do	do	259	10,950	3,338	Hercules Powder Co., Wilmington, Del.
Xpdite No. 2	do	do	302	11,380	3,470	Do.
Xpdite No. 3	do	do	325	8,710	2,656	Do.
Xpdite No. 4	do	do	327	7,670	2,339	Do.
Xpdite No. 5	do	do	304	10,140	3,092	Do.
Xpdite No. 6	do	do	345	7,490	2,285	Do.

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UNIT DEFLECTIVE CHARGE AS DETERMINED BY THE BALLISTIC PENDULUM.

The figures in the fourth column of the table show the weight in grams of the quantity of explosive that is required to swing the pendulum mortar the same distance as one-half pound (227 grams) of the standard 40 per cent "straight" nitroglycerin dynamite of the Pittsburgh Testing Station. Many observers have expressed the opinion that the "coal-getting" strength of permissible explosives is represented better by the results of this test than by the results of any other single test yet devised. The reader should note that the results do not take into consideration whether the coal when shot down is fine or coarse.

THE RATE OF DETONATION.

The table shows, in feet per second and meters per second, the relative velocity of detonation of the explosives. The adaptability of a permissible explosive to a particular coal-mining condition depends greatly on its rate of detonation. For certain work in which a shattering effect is desired, as in driving through or "brushing" rock, or in producing coal for coke making, the explosive reaction should be rapid, and for such work permissible explosives having a high rate of detonation should be selected. Similarly, for shooting down a soft friable coal to produce lump or steam coal, a permissible explosive should be selected that detonates slowly and hence gives a more prolonged pressure. In medium hard coal an explosive having an intermediate rate of detonation may be expected to be most suitable.

Although these relations usually hold, they do not always, because coals differ in hardness and coal beds differ in the number and position of the joints, partings, and shale bands. Such facts have to be considered in selecting an explosive for mining coal.

An explosive having a very low rate of detonation is not always the best for mining a soft friable coal, because some of its energy may be lost by its gases escaping through cracks and fractures in the bed. Under such conditions an explosive having an intermediate rate produces the most economical results.

CLASSES OF PERMISSIBLE EXPLOSIVES.

In order that the user of explosives may know the nature and characteristic component of each of the permissible explosives, and that he may be able to select an explosive to meet a specific requirement, the designation and characteristics of each class are given below:

Class 1, ammonium-nitrate explosives.—To class 1 belong all the explosives in which the characteristic material is ammonium nitrate.

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The class is divided into two subclasses. Subclass *a* includes every ammonium-nitrate explosive that contains a sensitizer that is itself an explosive. Subclass *b* includes every ammonium-nitrate explosive that contains a sensitizer that is not in itself an explosive. The ammonium-nitrate explosives of subclass *a* consist principally of ammonium nitrate with small percentages of nitroglycerin, nitrocellulose, or nitrosubstitution compounds which are used as sensitizers. The ammonium-nitrate explosives of subclass *b* consist principally of ammonium nitrate with small percentages of resinous matter or other nonexplosive substances used as sensitizers.

All of the ammonium-nitrate explosives readily absorb moisture from the atmosphere, and great care should be taken in storing them or in using them in damp places. They are not suitable for use in wet mines. If in such mines a cartridge of an ammonium-nitrate explosive is opened and its contents exposed for only a few hours to the damp atmosphere, the explosive may deteriorate and later fail to detonate completely. The ammonium-nitrate explosives when stored in well-ventilated magazines for only a few months have shown signs of deterioration. For this reason the ammonium-nitrate explosives should be obtained in a fresh condition and should be used as soon as possible after their receipt. When fresh, these explosives, if properly detonated, have the advantage of producing only small quantities of poisonous and inflammable gases, and are adapted for mines that are not unusually wet, and also for mines and working places that are not well ventilated.

Class 2, hydrated explosives.—To class 2 belong all explosives in which salts containing water of crystallization are the characteristic materials. The explosives of this class are somewhat similar in composition to the ordinary low-grade dynamites, except that one or more salts containing water of crystallization are added to reduce the flame temperature. They are easily detonated, produce only small quantities of poisonous gases, and most of them can be used successfully in damp working places.

Class 3, organic nitrate explosives.—To class 3 belong all the explosives in which the characteristic material is an organic nitrate other than nitroglycerin. The permissible explosives listed under class 3 are nitrostarch explosives. They produce small quantities of poisonous gases on detonation.

Class 4, nitroglycerin explosives.—To class 4 belong all the explosives in which the characteristic material is nitroglycerin. These explosives contain free water or an excess of carbon, which is added to reduce the flame temperature. A few explosives of this class contain salts that reduce the strength and shattering effect of the explosives on detonation. The nitroglycerin explosives have the advantages of detonating easily and of not being readily affected by moisture.

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On detonation some of them produce poisonous and inflammable gases equal in quantity to those produced by black blasting powder, and for this reason they should not be used in mines or working places that are not well ventilated.

PUBLICATIONS ON MINE ACCIDENTS AND TESTS OF EXPLOSIVES.

A limited supply of the following publications of the Bureau of Mines is temporarily available for free distribution. Requests for all publications can not be granted, and applicants should select only those publications that are of especial interest to them. All requests for publications should be addressed to the Director, Bureau of Mines, Washington, D. C.

BULLETIN 15. Investigations of explosives used in coal mines, by Clarence Hall, W. O. Snelling, and S. P. Howell, with a chapter on the natural gas used at Pittsburgh, by G. A. Burrell, and an introduction by C. E. Munroe. 1911. 197 pp., 7 pls., 5 figs.

BULLETIN 17. A primer on explosives for coal miners, by C. E. Munroe and Clarence Hall. 61 pp., 10 pls., 12 figs. Reprint of United States Geological Survey Bulletin 423.

BULLETIN 20. The explosibility of coal dust, by G. S. Rice, with chapters by J. C.W. Frazer, Axel Larsen, Frank Haas, and Carl Scholz. 204 pp., 14 pls., 28 figs. Reprint of United States Geological Survey Bulletin 425.

BULLETIN 46. An investigation of explosion-proof mine motors, by H. H. Clark. 1912. 44 pp., 6 pls., 14 figs.

BULLETIN 51. The analysis of black powder and dynamite, by W. O. Snelling and C. G. Storm. 1913. 80 pp., 5 pls., 5 figs.

BULLETIN 52. Ignition of mine gases by the filaments of incandescent electric lamps, by H. H. Clark and L. C. Ilsley. 1913. 31 pp., 6 pls., 2 figs.

BULLETIN 56. First series of coal-dust explosion tests in the experimental mine, by G. S. Rice, L. M. Jones, J. K. Clement, and W. L. Egy. 1913. 115 pp., 12 pls., 28 figs.

BULLETIN 59. Investigations of detonators and electric detonators, by Clarence Hall and S. P. Howell. 1913. 73 pp., 7 pls., 5 figs.

BULLETIN 66. Tests of permissible explosives, by Clarence Hall and S. P. Howell, 1913. 313 pp., 1 pl., 6 figs.

BULLETIN 68. Electric switches for use in gaseous mines, by H. C. Clark and R. W. Crocker. 1913. 40 pp., 6 pls.

BULLETIN 69. Coal-mine accidents in the United States and foreign countries, compiled by F. W. Horton. 1913. 102 pp., 3 pls., 40 figs.

TECHNICAL PAPER 6. The rate of burning of fuse as influenced by temperature and pressure, by W. O. Snelling and W. C. Cope. 1912. 28 pp.

TECHNICAL PAPER 7. Investigations of fuse and miners' squibs, by Clarence Hall and S. P. Howell. 1912. 19 pp.

TECHNICAL PAPER 11. The use of mice and birds for detecting carbon monoxide after mine fires and explosions, by G. A. Burrell. 1912. 15 pp.

TECHNICAL PAPER 12. The behavior of nitroglycerin when heated, by W. O. Snelling and C. G. Storm. 1912. 14 pp., 1 pl., 2 figs.

TECHNICAL PAPER 13. Gas analysis as an aid in fighting mine fires, by G. A. Burrell and F. M. Seibert. 1912. 16 pp., 1 fig.

TECHNICAL PAPER 17. The effect of stemming on the efficiency of explosives, by W. O. Snelling and Clarence Hall. 1912. 20 pp., 11 figs.

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TECHNICAL PAPER 18. Magazines and thaw houses for explosives, by Clarence Hall and S. P. Howell. 1912. 34 pp., 1 pl., 5 figs.

TECHNICAL PAPER 21. The prevention of mine explosions, report and recommendations, by Victor Watteyne, Carl Meissner, and Arthur Desborough. 12 pp. Reprint of United States Geological Survey Bulletin 369.

TECHNICAL PAPER 30. Mine-accident prevention at Lake Superior iron mines, by D. E. Woodbridge. 1913. 38 pp., 9 figs.

TECHNICAL PAPER 39. The inflammable gases in mine air, by G. A. Burrell and F. M. Seibert. 1913. 24 pp., 2 figs.

TECHNICAL PAPER 40. Metal-mine accidents in the United States during the calendar year 1911, compiled by A. H. Fay. 1913. 54 pp.

TECHNICAL PAPER 43. The influence of inert gases on inflammable gaseous mixtures, by J. K. Clement. 1913. 24 pp., 1 pl., 8 figs.

TECHNICAL PAPER 44. Safety electric switches for mines, by H. H. Clark. 1913. 8 pp.

TECHNICAL PAPER 46. Quarry accidents in the United States during the calendar year 1911, compiled by A. H. Fay. 1913. 32 pp.

TECHNICAL PAPER 47. Portable electric mine lamps, by H. H. Clark. 1913. 13 pp.

TECHNICAL PAPER 48. Coal-mine accidents in the United States, 1896–1912, with monthly statistics for 1912, compiled by F. W. Horton. 1913. 74 pp., 10 figs.

TECHNICAL PAPER 52. Permissible explosives tested prior to March 1, 1913, by Clarence Hall. 1913. 11 pp.

TECHNICAL PAPER 59. Fires in Lake Superior iron mines, by Edwin Higgins. 1913. 34 pp., 2 pls.

TECHNICAL PAPER 61. Metal-mine accidents in the United States during the calendar year 1912, compiled by A. H. Fay. 1913. 76 pp., 1 fig.

TECHNICAL PAPER 62. Relative effects of carbon monoxide on small animals, by G. A. Burrell, F. M. Seibert, and I. W. Robertson. 1914. 23 pp.

TECHNICAL PAPER 67. Mine signboards, by Edwin Higgins and Edward Steidle. 1913. 15 pp., 1 pl., 4 figs.

TECHNICAL PAPER 71. Permissible explosives tested prior to January 1, 1914, by Clarence Hall. 1914. 12 pp.

TECHNICAL PAPER 77. Report of the Committee on Resuscitation from Mine Gases, by W. B. Cannon, G. W. Crile, Joseph Erlanger, Yandell Henderson, and S. J. Meltzer. 1914. 36 pp., 4 figs.

TECHNICAL PAPER 92. Quarry accidents in the United States during the calendar year 1913, compiled by A. H. Fay. 1914. 76 pp.

TECHNICAL PAPER 94. Metal-mine accidents in the United States during the calendar year 1913, compiled by A. H. Fay. 1914. 73 pp.

MINERS' CIRCULAR 4. The use and care of mine-rescue breathing apparatus, by J. W. Paul. 1911. 24 pp., 5 figs.

MINERS' CIRCULAR 5. Electrical accidents in mines, their causes and prevention, by H. H. Clark, W. D. Roberts, L. C. Ilsley, and H. F. Randolph. 1911. 10 pp., 3 pls.

MINERS' CIRCULAR 7. Use and misuse of explosives in coal mining, by J. J. Rutledge, with a preface by J. A. Holmes. 1913. 52 pp., 8 figs.

MINERS' CIRCULAR 8. First-aid instructions for miners, by M. W. Glasgow, W. A. Raudenbush, and C. O. Roberts. 1913. 67 pp., 51 figs.

MINERS' CIRCULAR 10. Mine fires and how to fight them, by J. W. Paul. 1912. 14 pp.

MINERS' CIRCULAR 11. Accidents from mine cars and locomotives, by L. M. Jones. 1912. 16 pp.

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MINERS' CIRCULAR 12. The use and care of miners' safety lamps, by J. W. Paul. 1913. 16 pp., 4 figs.

MINERS' CIRCULAR 13. Safety in tunneling, by D. W. Brunton and J. A. Davis. 1913. 19 pp.

MINERS' CIRCULAR 14. Gases found in coal mines, by G. A. Burrell and F. M. Seibert. 1914. 23 pp.

MINERS' CIRCULAR 15. Rules for mine-rescue and first-aid field contests, by J. W. Paul. 1913. 12 pp.

MINERS' CIRCULAR 16. Hints on coal-mine ventilation, by J. J. Rutledge. 1914. 22 pp.

MINERS' CIRCULAR 17. Accidents from falls of rock or ore, by Edwin Higgins. 1914. 15 pp., 8 figs.

MINERS' CIRCULAR 21. What a miner can do to prevent gas and dust explosions, by G. S. Rice. 1914. 22 pp.

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